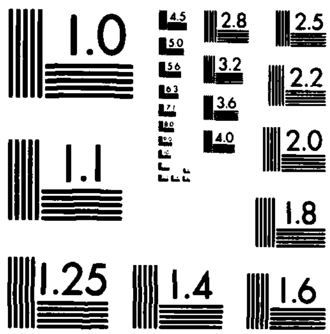
AD-A164 160 SARSAT CANADIAN MISSION CONTROL CENTRE TCA TESTS AT 1/1
1215 MHZ RESOLUTE BAY 27-28 MAY 1984(U) DEFENCE
RESEARCH ESTABLISHMENT OTTAWA (ONTARIO) W R MCPHERSON
UNCLASSIFIED JUL 85 DREO-TN-85-16 F/G 17/7 NL



MICROCOPY RESOLUTION TEST CHART
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AD-A164 160

SARSAT CANADIAN MISSION CONTROL CENTRE TCA TESTS AT 121.5 MHz RESOLUTE BAY, 27-28 MAY 1984

by

W.R. McPherson

DEFENCE RESEARCH ESTABLISHMENT OTTAWA
TECHNICAL NOTE 85-16

Canada

July 1985
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SARSAT
CANADIAN MISSION CONTROL CENTRE
TCA TESTS AT 121.5 MHz
RESOLUTE BAY, 27-28 MAY 1984

by

W.R. McPherson
SARSAT Project Office
Electronics Division

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ABSTRACT

The Canadian SARSAT users initiated field trials to test the performance of the SARSAT ground station under the conditions of fringe coverage. The data generated as a result of these trials was analyzed and results are presented. It is concluded that SARSAT can function adequately under such conditions but that this performance can only be recognized by users, if they have better visibility into available signal processing quality indicators.

RÉSUMÉ

Les usagers canadiens du système SARSAT ont mené des essais opérationnels afin d'évaluer la performance d'une station terrestre SARSAT dans des conditions de réception limitrophe. Les données recueillies à la suite de ces essais ont fait l'bjet d'une analyse et les résultats ont révélé que le système SARSAT peut fonctionner adéquatement dans des conditions de réception limitrophe. Il importe de signaler toutefois que seuls les usagers peuvent reconnaître cette performance s'ils sont sensibilisés davantage à la disponibilité des indicateurs de qualité en matière de traitement des signaux.

1.0 INTRODUCTION

The Canadian COSPAS-SARSAT users, and in particular the Officer-in-Charge of the Canadian Mission Control Centre (CMCC), were concerned about the performance of COSPAS-SARSAT under fringe coverage conditions. The particular condition of concern was the situation when the Time of Closest Approach (TCA) was either outside or near the edge of the ground tracking station's viewing window. In order to test the system under these conditions, the CMCC organized test activations of standard, commercially available Emergency Locator Beacons (ELTs) transmitting at 121.5 MHz through the Rescue Coordination Centre (RCC) Edmonton at a position on the periphery of the Ottawa SARSAT Local User Terminal (LUT) coverage. Tests were carried out at Resolute Bay (74.72N, 094.95W) on 27-28 May 84.

Evaluation personnel from the SARSAT Project Office at the Defence Research Establishment Ottawa, in analyzing the results of these tests, used the test data to illustrate developmental techniques which were being studied for the purposes of providing the Canadian COSPAS-SARSAT users with a more useful data package. It has been argued for some time that Canadian users are being provided too much extraneous data and at the same time they are being denied vital characterization data.

2.0 TEST/EVALUATION TECHNIQUE

Simply stated, the test conditions consisted of activating a commercially available ELT and leaving it on for the period in question. The test site was in northern extremes of Canada, a region of low ELT activity. Hence, the chance of interference from other ELT activity was considered low. Furthermore, Resolute Bay is at the extreme of Ottawa LUT coverage and therefore the test would generate evaluation data reflecting LUT performance under fringe conditions.

During the Demonstration and Evaluation phase of the SARSAT Project, all LUT data were routinely stored on magnetic tape and transferred to the SARSAT Evaluation Facility (SEF) where they were loaded onto a data base. These data were then available in a structured form for evaluation purposes.

As the evaluation of the data proceeded, it became evident that the Resolute Bay tests could provide a convenient mechanism to illustrate the potential that exists in LUT data to enhance user visibility into what might be occurring. This in turn would allow the Canadian user community to make better operational use of the COSPAS-SARSAT data.

This initial program of study led to a more indepth study which was subsequently carried out and documented elsewhere, see Ref. 1.

3.0 SUMMARY OF RESULTS

The summary results for the Resolute Bay tests are considered in terms of the data generated by the Ottawa LUT, the data passed to the CMCC, and the data the CMCC should have received (cluster analysis).

3.1 THE LUT DATA

Using the program LOCAT, see Ref. 2, the SEF data base was queried for all LUT generated ELT detections for the period 27-28 May 1984 within a radius of 250 km around the position 74.72N, 94.95W. The output from this query is illustrated in Tables 1(a) and 1(b). Note that the image data is not listed because the CMCC data was not integrated into the data base.

Table 1(a) identifies the pass, the estimated location of the ELT, the associated error and flag information (MCC Reference No., LUT event number, flag concerning whether CMCC was sent a message, and frequency band). Table 1(b) provides a subset of available LUT parameters which should be used to characterize the estimate.

Considering the total LUT data set, the following comments are made. The LUT provided 26 discrete detections on eight passes during the two day period. Three passes involved the SARSAT satellite and five passes used the COSPAS satellites. The location error ranged from a minimum of 4.46 km to a maximum of 232.45 km with a mean error of estimation being 49.1 km.

Referring to Table 1(b) and the PROB column, it should be noted that the LUT was totally unable to resolve ambiguity. On three occasions it chose the image location as the primary position, on five occasions it made the right choice, and on the remaining eighteen it gave equal weight to both locations.

TABLE 1(a)

Located Data - Primary
Resolute Bay, 27-28 May 84

	PRIMARY DATA						PRIMARY		SECONDARY				
	DATE	SATPAS	MCCREF	EVENT	MESSNT		ELTLAT	ELTLONG	ELTLAT	ELTLONG	DIFF	DLAT	DLONG
LOCATION LATITUDE -		74.7167	LONGITUDE -		-94.9500	RADIUS -		250.0					
1)	840527	C1 09541	0	2	1	8	74.9518	-95.0836			26.4580	26.1701	-3.8616
2)	840527	C1 09541	0	3	0	8	74.6463	-96.2523			39.0923	-7.8373	-38.3846
3)	840527	C1 09541	0	4	0	8	74.9656	-94.9376			27.7099	27.7075	.3578
4)	840527	C1 09542	0	2	1	8	74.7542	-94.4638			14.8478	4.1741	14.2317
5)	840527	C1 09542	0	3	0	8	74.7822	-94.5652			13.4203	7.2899	11.2437
6)	840527	C1 09542	0	4	0	8	74.7461	-94.4667			14.5407	3.2709	14.1542
7)	840527	C1 09542	0	5	0	8	74.7706	-94.4163			16.7447	5.9989	15.6056
8)	840527	C1 09542	0	9	1	8	74.6940	-92.6233			68.3639	-2.5273	68.3694
9)	840527	S1 06060	0	1	1	8	75.6398	-91.0915			150.3389	102.7568	106.5271
10)	840527	S1 06060	0	2	1	8	75.1606	-93.3897			66.9202	49.4130	44.4834
11)	840528	C1 09546	0	1	1	8	74.8885	-94.7193			20.2740	19.1235	6.6949
12)	840528	C1 09546	0	2	0	8	74.8248	-94.8406			12.4508	12.0328	3.1877
13)	840528	C1 09546	0	3	0	8	75.1318	-94.1811			51.2909	46.2075	21.9622
14)	840528	C1 09546	0	4	1	8	73.0362	-99.4200			232.4500	-187.0699	-145.1801
15)	840528	C1 09548	0	4	1	8	74.7566	-94.9636			4.4597	4.4418	-.3978
16)	840528	C1 09548	0	6	0	8	74.7521	-95.3952			13.6309	3.9415	-13.0338
17)	840528	C1 09548	0	7	1	8	74.6888	-97.9787			88.9949	-3.1067	-89.0273
18)	840528	C2 05905	0	2	1	8	74.7669	-95.0148			5.9021	5.5883	-1.8954
19)	840528	C2 05905	0	4	0	8	74.7791	-94.9304			6.9692	6.9463	.5725
20)	840528	C2 05905	0	5	0	8	74.7718	-94.9541			6.1348	6.1342	-.1202
21)	840528	C2 05905	0	9	0	8	74.7895	-94.9351			8.1157	8.1035	.4349
22)	840528	C2 05905	0	14	0	8	74.8004	-95.4854			18.2289	9.3169	-15.6260
23)	840528	S1 06061	0	2	1	8	74.6997	-95.3561			12.0718	-1.8917	-11.9287
24)	840528	S1 06061	0	3	1	8	74.6138	-95.6764			24.2598	-11.4549	-21.4548
25)	840528	S1 06068	0	1	1	8	73.4009	-100.1231			215.4372	-146.4720	-164.5065
26)	840528	S1 06068	0	4	1	8	74.0647	-98.0401			117.5997	-72.5798	-94.4407

TABLE 1(b)

Located Data - Secondary
Resolute Bay, 27-28 May 84

	CTA	SECOND PRIMARY POINTS	OUTPUT LOCATION SDEV	TREND	QUAL	PROB	NMWLS	TCA	QTIME	LOSTIM	BIAS		CORR SCORE	
1)	9.2608	156	5.1351	1.6981	885	50	2	21.4012	21.1089	21.4072	14760.	8224	8224	18688
2)	9.6126	110	9.3293	1.1723	370	48	2	21.4000	21.1089	21.4072	15444.	8224	8224	17408
3)	9.2211	93	9.6695	3.3412	307	53	5	21.4013.	21.1089	21.4072	14114.	8224	8224	30208
4)	2.2140	219	5.7240	0.8037	834	50	2	23.1591	22.9186	23.1669	16055.	8224	8224	23552
5)	2.2481	207	5.8571	2.0905	825	50	1	23.1592	22.9186	23.1669	14782.	8224	8224	23040
6)	2.2122	172	7.4350	1.5905	454	50	2	23.1591	22.9186	23.1669	16676.	8224	8224	21248
7)	2.2071	247	4.0835	1.5691	1681	50	1	23.1592	22.9186	23.1669	15427.	8224	8224	22528
8)	1.7326	81	17.1110	3.8180	221	50	3	23.1596	22.9186	23.1669	13517.	8224	8224	21504
9)	1.4313	158	4.1895	2.6638	919	50	3	22.7704	22.5311	22.7483	15368.	8224	8224	30208
10)	2.1819	124	7.8964	2.3829	417	50	4	22.7708	22.5311	22.7483	16004.	8224	8224	27648
11)	-5.4045	161	6.6055	1.8263	582	50	2	6.2957	6.3161	6.5636	16669.	8224	8224	16640
12)	-5.4752	195	5.0285	2.9826	1215	51	2	6.2958	6.3161	6.5636	16033.	8224	8224	31744
13)	-5.1241	85	9.0237	1.5796	221	50	2	6.2956	6.3161	6.5636	17314.	8224	8224	31744
14)	-7.6774	140	18.3580	15.4176	622	50	4	6.2954	6.3161	6.5636	15253.	8224	8224	30720
15)	6.3607	184	4.0238	2.0205	1158	48	2	9.8392	9.8600	10.0914	16033.	8224	8224	16896
16)	6.2464	160	6.2684	2.4491	575	50	2	9.8392	9.8600	10.0914	16674.	8224	8224	30720
17)	5.5585	97	15.2490	4.4972	260	50	-5	9.8392	9.8600	10.0914	17336.	8224	8224	31744
18)	4.4181	219	5.5586	1.7694	801	50	2	4.2740	4.0097	4.2850	16514.	8224	8224	24832
19)	4.3981	201	5.6684	1.2093	740	51	2	4.2741	4.0097	4.2850	15228.	8224	8224	22784
20)	4.4030	233	3.2301	1.0319	1649	49	1	4.2740	4.0097	4.2850	15884.	8224	8224	22528
21)	4.4011	138	7.6104	1.9257	355	51	2	4.2741	4.0097	4.2850	17134.	8224	8224	23808
22)	4.5462	50	11.3864	1.4353	123	50	2	4.2740	4.0097	4.2850	13987.	8224	8224	27136
23)	-2.4191	150	7.0575	5.6245	976	53	-5	0.4406	0.1706	0.4258	15660.	8224	8224	16896
24)	-2.3047	131	8.5459	2.2831	453	50	2	0.4404	0.1706	0.4258	16290.	8224	8224	16640
25)	-16.3380	105	19.5473	11.0157	540	50	5	12.3967	12.4136	12.6597	15641.	8224	8224	17408
26)	-15.5344	84	23.8881	8.8025	271	50	2	12.3948	12.4136	12.6597	16368.	8224	8224	21504

3.2 THE CMCC DATA

The LUT has a sideband filter which reduces extraneous detections going to the CMCC. This filter is based on a distance criteria and is only available for the COSPAS satellites.

In the case of the Resolute Bay tests, 14 detections passed the LUT filter. The CMCC visibility into results indicated a location error ranging from a minimum of 4.4 km to a maximum of 232.5 km with a mean error of estimation being 74.9 km. This increase in error is due to good sideband estimates for COSPAS satellites being held at the LUT while the CMCC received bad sideband estimates for the SARSAT satellite.

Mean error estimates by satellite at each facility, i.e. LUT and CMCC, are summarized in Table 2.

TABLE 2

Mean Error of Location (Km)

	Satellite		
	COSPAS	SARSAT	BOTH
LUT	34.5	97.8	49.1
CMCC	57.7	97.8	74.9

A number of items are apparent from the data in Table 2. Firstly, it is evident that COSPAS is performing better than SARSAT. This however is a known fact. Secondly, while it is necessary to have sideband filtering available, the CMCC without additional information is actually losing location resolution.

This now leads into a discussion concerning what data the CMCC should receive.

3.3 CLUSTER DATA

Table 3(a) and 3(b) contain the data which the CMCC should have received. It consists of nine detections. Table 3(a) would constitute the operational data while Table 3(b) contains the parameter information. It is suggested that Table 3(b) data while of necessity be available at the CMCC, they are only required on an exception basis.

TABLE 3(a)

Cluster Data - Primary
Resolute Bay, 27-28 May 84

Primary Data for the first element in each cluster

PASS #	CL #	CL SIZE	# DET	SEQ #	DATE	SATPAS	EVENT	MESSG	FREQ	LAT	LONG	REGION	PROBS	PROBT	QP	CTA	TCA	Flags STD	TREND	FREQ
1	1	3	1	1	840527	C1 09541	2	1	8	74.9518	-95.0836		50	46	.5954	1	0	0	0	8
										68.4582	-39.4700		50	54	.5954			0	0	
2	1	2	1	4	840527	S1 06060	1	1	8	75.6398	-91.0915		50	50	.7678	0	1	0	0	8
										77.3864	-82.4490		50	50	.7678			0	0	
3	1	5	1	6	840527	C1 09542	2	1	8	74.7542	-94.4638		50	59	.8245	1	0	0	0	8
										73.0106	-80.9718		50	41	.8245			0	0	
4	1	2	1	11	840528	S1 06061	2	1	8	74.6997	-95.3561		53	82	.6806	1	0	0	1	8
										71.5650	-107.4454		47	18	.0590			0	2	
5	1	5	1	13	840528	C2 05905	2	1	8	74.7669	-95.0148		50	51	.8051	1	0	0	0	8
										71.3938	-68.1011		50	49	.8051			0	0	
6	1	3	1	18	840528	C1 09546	1	1	8	74.8085	-94.7193		50	49	.7696	1	1	0	0	8
										81.2669	-48.1382		50	51	.7696			0	0	
	2	1	4	21	840528	C1 09546	4	1	8	73.0362	-99.4200		50	50	.6711	1	1	1	2	8
										81.4306	-32.3261		50	50	.6711			1	2	
7	1	3	1	22	840528	C1 09548	4	1	8	74.7566	-94.9636		48	48	.8829	1	1	0	0	8
										70.0103	-133.5229		52	52	.8781			0	0	
8	1	2	1	25	840528	S1 06068	1	1	8	73.4009	-100.1231		50	50	.4857	1	1	2	2	8
										59.7966	-11.6798		50	50	.4857			2	2	

TABLE 3(b)

Cluster Data - Secondary
Resolute Bay, 27-28 May 84

Secondary Data for the first element in each cluster

PASS #	# DET	SEQ #	CTA	BIAS	PTS	PPTS	STD	TREND	PROBS	PROBT	DP	TCA	AOS	DTCA	LOS	MAJOR	MINOR	DRIFT
1	1	1	9.2608	14760.	156	298	5.1351	1.6981	50	46	-4	21.4012	21.1089	8.6	21.4072	8.932	2.206	0.0000
			-8.6523	14796	156	298	5.0494	1.4582	50	54	4		21.1089		21.4072	8.069	2.003	0.0000
2	4	2	1.4313	15368.	158	384	4.1895	2.6638	50	50	0	22.7704	22.5311	7.8	22.7403	50.368	1.966	0.0000
			-1.2478	15376	158	384	4.2146	2.6998	50	50	0		22.5311		22.7483	51.070	1.956	0.0000
3	6	3	2.2140	16055.	219	412	5.7240	0.8037	50	59	9	23.1591	22.9186	7.0	23.1669	13.671	1.192	0.0000
			-1.9305	16065	219	412	5.6638	1.1352	50	41	-9		22.9186		23.1669	13.211	1.160	0.0000
4	11	4	-2.4191	15660.	150	340	7.0575	5.6245	53	82	29	0.4406	0.1706	8.5	0.4258	33.546	2.375	0.0000
			2.2234	15591	13	29	8.0017	26.1090	47	18	-29		0.1706		0.4258	9999.000	483.345	0.0000
5	13	5	4.4181	16514.	219	403	5.5586	1.7694	50	51	1	4.2740	4.0097	7.6	4.2850	7.035	1.248	0.0000
			-4.0661	16534	219	403	5.5992	1.8334	50	49	-1		4.0097		4.2850	6.813	1.214	0.0000
6	18	6	-5.4045	16669.	161	385	6.6055	1.8263	50	49	-1	6.2957	6.3161	-8.6	6.5636	28.487	2.905	0.0000
			5.7234	16700	161	385	6.6047	1.7736	50	51	1		6.3161		6.5636	29.706	3.087	0.0000
6	21	7	-7.6774	15253.	140	336	18.3580	15.4176	50	50	0	6.2954	6.3161	-8.7	6.5636	74.882	9.406	0.0000
			8.1123	15295	140	336	18.3776	15.4288	50	50	0		6.3161		6.5636	78.896	10.260	0.0000
7	22	8	6.3607	16033.	184	441	4.0238	2.0205	48	48	0	9.8392	9.8600	-8.2	10.0914	14.873	1.728	0.0000
			-6.0325	16001	183	439	3.6791	1.8638	52	52	0		9.8600		10.0914	13.073	1.490	0.0000
8	25	9	-16.3380	15641.	105	243	19.5473	11.0157	50	50	0	12.3967	12.4136	-8.4	12.6597	131.843	20.229	0.0000
			17.5297	15701	105	243	19.4970	10.9351	50	50	0		12.4136		12.6597	150.555	23.648	0.0000

The data are the result of merging sidebands within the pass according to a distance criteria (250 km) and an ELT bias check (3000 Hz). In addition, a quality factor which is an indicator of density of the Doppler curve correcting for the amount of the curve seen by the LUT is provided. Finally, three types of flag information are provided. The first gives an indication of the goodness of the geometry, i.e. the Cross Track Angle (CTA) at TCA, and the TCA flags, the second type describes the structure of the Doppler curve, i.e. Standard Deviation (STD) and Trend, and the third resolves dual frequency beacons (SARSAT only).

The flag definitions used were as follows:

CTA Flag:	0	CTA $< 2^\circ$
	1	$2^\circ \leq$ CTA $< 18^\circ$
	2	CTA $\geq 18^\circ$
TCA Flag:	0	unless
		TCA < (AOS - 60 seconds)
		or TCA > (LOS + 60 seconds)
STD Flag:	0	$0 \leq$ STD < 9
	1	$9 \leq$ STD < 19
	2	$19 \leq$ STD < 28
	3	STD ≥ 28
TREND Flag:	0	$0 \leq$ TREND < 5
	1	$5 \leq$ TREND < 10
	3	TREND ≥ 10
FREQ Flag:	121.5 MHz	8
	243 MHz	16
	121.5/243 MHz	24

The data given in Table 3 are summarized in Table 4 to illustrate how operationally, merged data could be actioned.

TABLE 4

RESOLUTE BAY
MERGE SUMMARY

PASS	SAT PASS	ERROR (KM)	CLUSTER SIZE	QUALITY	FLAGS				CATEGORY
					CTA	TCA	STD	TREND	
1	C1 9541	26.5	3	0.60	1	0	0	0	GOOD
2	S1 6060	150.4	2	0.77	0	1	0	0	POOR
3	C1 9542	14.8	5	0.82	1	0	0	0	EXCELLENT
4	S1 6061	12.1	2	0.68	1	0	0	1	GOOD
5	C1 5905	5.9	5	0.81	1	0	0	0	EXCELLENT
6	C1 9546	20.3	3	0.77	1	1	0	0	GOOD
	C1 9546	232.5	1	0.67	1	1	1	2	BAD
7	C1 9548	4.5	3	0.88	1	1	0	0	EXCELLENT
8	S1 6068	215.4	2	0.49	1	1	2	2	BAD

3.4 DATA CATEGORIZATION

Subsequent work at DREO developed additional approaches to analytically categorize LUT generated alerts based upon a parameter set as illustrated in Table 3, See Ref. 1. For the purpose of analyzing the Resolute Bay tests, an intuitative categorization was made and is given in Table 4. Given that the CMCC has the data from Table 3 available, it could categorize the LUT alerts along the approaches now described.

On Pass 1, the cluster size was 3, indicative of a carrier plus 2 sidebands, hence a reasonable functioning ELT. The quality indicator was acceptable but not spectacular. Geometry and data quality flags were all okey. Hence, not a spectacular detection, but a solid good detection.

Pass 2 suffered a number of shortcomings. Firstly, the cluster size is small. Clusters of size 1 or 2 appear to be "orphan activities". Secondly, geometry is bad. However, for what curve is available, the data is solid. Hence, it is not a bad detection, but it is obviously a poor one.

Pass 3 seems to have everything going for it. It is simply classified excellent.

Pass 4 has a few problems. The cluster size is down, and there is some question about data quality, i.e. the Trend flag is on and the Quality factor is low. However, geometry is good. On this subjective basis it is classified good.

Pass 5 like pass 3 requires no discussion. It is judged excellent.

Pass 6 provided two estimates. The second estimate is an obvious sideband. One geometry and two data quality flags are indicating poor results. Furthermore the single element cluster suggests a sideband that missed the cluster filter. It is judged bad data. The first estimate in Pass 6 is obviously the primary location. However, the TCA flag is on and therefore the data is categorized as good.

Pass 7 is a problem to classify. Cluster size is reasonable (a cluster size of 2 seems to be a threshold), the TCA flag is on but quality is very high. The classification is somewhere between good and excellent, and excellent was aribitarily chosen.

Pass 8 requires no discussion. It is obviously a bad estimate.

4.0 DISCUSSION

It is apparent from the foregoing analysis that the Ottawa LUT, even under conditions of fringe coverage, can produce good results. The problem is that the operational personnel at the CMCC are not able to distinguish good data from bad data because they do not have sufficient visibility into the total LUT parameter set.

Volume is the biggest problem faced by the Canadian COSPAS-SARSAT user. While the Resolute Bay tests provide a very restricted sample from which to extrapolate cluster merging effects on data volume, the following comments are made. The LUT started out with 26 detections, the sideband filter reduced the data to 9 detections. Furthermore, with ancilliary data provided by the cluster analysis, 3 poor or bad alerts were easily recognized. Therefore of the 26 LUT detections, 20 can be screened out as either not being operationally useful data (the 17 detections filtered out by the cluster analysis) or data of such dubious quality that, in isolation, immediate operational action should not be taken (the 3 latter detections). This filtering could imply a 77% reduction in data volume from LUT to the actioning CMCC operator with no loss in operational effectiveness. In fact, with increased visibility into data quality, operational effectiveness is enhanced.

Table 5 expands on Table 2 to illustrate enhanced confidence in location estimation following a cluster analysis.

TABLE 5

MEAN ERROR OF LOCATION (Km)

	Satellite		
	COSPAS	SARSAT	ALL
LUT	34.5	97.8	49.1
CMCC			
. Current Filter	57.7	97.8	74.9
. Cluster Filter			
Excellent/Good Data	14.4	12.1	14.0
Poor/Bad Data	182.9	232.5	199.4

The implication in quoting enhanced confidence, as illustrated in Table 5, is that CMCC operators must have facilities to recognize good and bad data. The analysis of the Resolute Bay tests demonstrate that facilities do exist within the current LUT data set.

The discussion so far has concentrated on having a historical perspective on a known beacon activation during a know time period. This is not the normal operational environment at the CMCC. In order to illustrate clustering capabilities on a pass-by-pass basis, one particular pass, C1 09542, 27 May 84 is considered.

Table 6 illustrates a minimum data set that could be sent by the LUT to the CMCC for operational processing. Data packing in the example given could consist of twelve records, a header record and eleven data records.

As a result of the cluster analysis four data displays are generated. These include:

Operational Data Set (Primary Data)
Operational Data Set (Secondary Data) - Parameter
Cluster Data Set (Primary Data)
Cluster Data Set (Secondary Data) - Parameter

TABLE 6

Sample Transfer Data Set
LUT to CMCC

SAT Pass: C1 09542 AOS: 22.9186
Time: 840527 LOS: 23.1669

Seq. No.	LUT Seq.	Freq.	Primary ELTLAT	Primary ELTLONG	Secondary ELTLAT	Secondary ELTLONG
1)	1	8	44.7677	-118.5648	42.5169	- 89.2099
2)	2	8	73.0106	- 80.9718	74.7542	- 94.4638
3)	3	8	74.7822	- 94.5652	73.0116	- 80.8571
4)	4	8	73.0061	- 80.9967	74.7461	- 94.4667
5)	5	8	73.0305	- 80.9567	74.7706	- 94.4163
6)	6	8	36.0704	- 94.3136	37.3911	-113.5813
7)	7	8	36.0615	- 95.3960	37.3662	-113.4967
8)	8	8	25.7772	-100.8325	26.3154	-109.0557
9)	9	8	73.3308	- 82.1293	74.6940	- 92.6233
10)	10	8	44.6901	-118.1331	42.5145	- 89.5930
11)	11	8	42.4615	-125.6715	39.6361	- 83.2387

Parameters - Primary Location

	CTA	POINTS	SDEV	TREND	NMWLS	TCA	BIAS
1)	11.0759	314	10.6123	2.2657	2	23.0099	14589.
2)	-1.9305	219	5.6638	1.1352	2	23.1589	16065.
3)	2.2481	207	5.8571	2.0905	1	23.1592	14782.
4)	-1.9266	172	7.3423	1.9567	2	23.1589	16686.
5)	-1.9240	247	4.0283	1.4274	1	22.9734	15437.
6)	-7.1370	108	17.1609	8.9501	2	22.9734	8252.
7)	-7.0730	100	16.3438	8.7486	3	22.9733	7626.
8)	-3.9139	117	24.7359	10.7925	-5	22.9196	12834.
9)	-1.4769	81	17.0974	3.7443	3	23.1595	13525.
10)	10.7741	96	20.7957	3.1007	4	23.0094	14208.
11)	16.4584	136	15.2269	5.7642	3	23.0015	11845.

Parameters - Secondary Location

	CTA	POINTS	SDEV	TREND	NMWLS	TCA	BIAS
1)	-10.2371	318	11.9351	5.6294	2	23.0105	14568.
2)	2.2140	219	5.7240	0.8037	2	23.1591	16055.
3)	-1.9590	207	5.9432	2.3200	1	23.1590	14793.
4)	2.2122	172	7.4350	1.5905	2	23.1591	16676.
5)	2.2071	247	4.0835	1.5691	1	23.1592	15427.
6)	7.5750	107	17.6056	9.8031	3	22.9732	8262.
7)	7.5077	100	16.7639	9.1539	3	22.9731	7636.
8)	3.5019	118	25.6544	8.6011	3	22.9195	12862.
9)	1.7326	81	17.1110	3.8180	3	23.1596	13517.
10)	-9.9660	96	21.6035	6.1796	3	23.0101	14187.
11)	-15.4231	135	16.6356	6.4050	2	23.0038	11781.

These data are illustrated in Table 7(a)-(d). Note that in the secondary data set, a number of LUT parameters not given in Table 6, are provided. The utility of these parameters, i.e. Major, Minor and Drift are still being investigated. It should also be noted that Table 7 data are not considered as operational displays. However, they do include all the data required for CMCC operator action.

Referring now to Table 7(a), the following operator actions are envisaged. Clusters 3, 4 and 5 require no immediate action. In the absence of external (or previous pass data), the information provided is too ambiguous to do anything with. Data quality is low, and cluster sizes are small. It is even suggested that such data be surpressed from the CMCC operator as "orphan alerts" until such time as additional pass data is correlated to it. Clusters 1 and 2 requires attention. Cluster 1 is good data although the cluster size is small. However this negative factor is counter-balanced by the high quality of the data and the apparent image resolute capability, amplified by the PROB factor calculated using Trend. Cluster 2 requires no discussion. It is the beacon in Resolute Bay.

Tables 7(c) and (d) are the detailed cluster data which provide the additional information on the structure of the cluster. These data are only required on a exception basis.

5.0 SUMMARY COMMENTS

The CMCC tests at Resolute Bay have been analyzed and the results presented. It has been demonstrated that the LUT can operate very well under the conditions of fringe coverage given that one has sufficient visibility into LUT available parameters to interpret the data.

Furthermore, the potential capability of CMCC operators to quickly and effectively action COSPAS-SARSAT data, assuming they are given the right data set, has been illustrated.

Statistical studies were initiated to develop supporting evidence for the methodologies outline (see Ref. 1). It was important to establish cluster analysis threshold parameters, e.g. distance and bias criteria. The utility of Trend as a ambiguity resolver versus Standard Deviation has to be demonstrated. The new quality factor, while looking very promising, must be validated. The size of the cluster seems to be a strong indicator of how CMCC operators should respond to COSPAS-SARSAT data. Finally, the specific data required at the CMCC from the LUT has to be specified.

TABLE 7(a)

Operational Data
Primary Data Set

PASS #	CL #	CL SIZE	# DET	SEQ #	DATE	SATPAS	EVENT	MESSG	FREQ	LAT	LONG	REGION	PROBS	PROBT	QP	CTA	TCA	Flags STD	TREND	FREQ
1	1	2	1	1	840527	C1 09542	1	1	8	44.7677	-118.5648		53	71	.7258	1	0	1	0	8
										42.5169	-89.2099		47	29	.7351			1	1	
	2	5	3	3	840527	C1 09542	2	1	8	73.0106	-80.9718		50	41	.8233	1	0	0	0	8
										74.7542	-94.4638		50	59	.8233			0	0	
	3	2	8	8	840527	C1 09542	6	1	8	36.0704	-95.3136		51	52	.3003	1	0	1	1	8
										37.3911	-113.5813		49	48	.2976			1	1	
	4	1	10	10	840527	C1 09542	8	1	8	25.7772	-100.8325		51	44	.4643	1	0	2	2	8
										26.3154	-109.0557		49	56	.4683			2	1	
	5	1	11	11	840527	C1 09542	11	1	8	42.4615	-125.6715		52	53	.3271	1	0	1	1	8
										39.6361	-83.2387		48	47	.3247			1	1	

TABLE 7(b)

Operational Data
Secondary Data Set

Secondary Data for the first element in each cluster

PASS #	# DET	SEQ #	CTA	BIAS	PTS	PPTS	STD	TREND	PROBS	PROBT	DP	TCA	AOS	DTCA	LOS	MAJOR	MINOR	DRIFT
1	1	1	11.0759	14589.	314	363	10.6123	2.2657	53	71	18	23.0099	22.9186	-2.0	23.1669	4.207	3.581	0.0000
			-10.2371	14568	318	368	11.9351	5.6294	47	29	-18		22.9186		23.1669	4.353	3.648	0.0000
1	3	2	-1.9305	16065.	219	412	5.6638	1.1352	50	41	-9	23.1589	22.9186	7.0	23.1669	13.211	1.160	0.0000
			2.2140	16055	219	412	5.7240	0.8037	50	59	9		22.9186		23.1669	13.671	1.192	0.0000
1	8	3	-7.1370	8252.	108	150	17.1609	8.9501	51	52	1	22.9734	22.9186	-4.2	23.1669	10.987	10.187	0.0000
			7.5750	8262	107	149	17.6056	9.8031	49	48	-1		22.9186		23.1669	12.323	11.011	0.0000
1	10	4	-3.9139	12834.	117	232	24.7359	10.7925	51	44	-7	22.9196	22.9186	-7.4	23.1669	64.931	7.857	0.0000
			3.5019	12862	118	234	25.6544	8.6011	49	56	7		22.9186		23.1669	66.920	7.908	0.0000
1	11	5	16.4584	11845.	136	164	15.2269	5.7642	52	53	1	23.0015	22.9186	-2.5	23.1669	16.414	9.360	0.0000
			-15.4231	11781	135	162	16.6356	6.4050	48	47	-1		22.9186		23.1669	17.374	9.058	0.0000

TABLE 7(c)

Cluster Data
Primary Data Set

PASS #	CL #	Primary Data CL SIZE	# DET	SEQ #	DATE	SATPAS	EVENT	MESSG	FREQ	LAT	LONG	REGION	PROBS	PROBT	QP	CTA	TCA	Flags STD	TREND	FREQ
1	1	2	1	1	840527	C1 09542	1	1	8	44.7677	-118.5648		53	71	.7258	1	0	1	0	8
										42.5169	-89.2099		47	29	.7351			1	1	
			2	2	840527	C1 09542	10	0	8	44.6901	-118.1331		51	67	.2224	1	0	2	0	
										42.5145	-89.5930		49	33	.2224			2	1	
1	2	5	3	3	840527	C1 09542	2	1	8	73.0106	-80.9718		50	41	.8233	1	0	0	0	8
										74.7542	-94.4638		50	59	.8233			0	0	
			4	4	840527	C1 09542	3	0	8	74.7822	-94.5652		50	53	.7799	1	0	0	0	
										73.0116	-80.8571		50	47	.7799			0	0	
			5	5	840527	C1 09542	4	0	8	73.0061	-80.9967		50	45	.6466	1	0	0	0	
										74.7461	-94.4667		50	55	.6466			0	0	
			6	6	840527	C1 09542	5	0	8	73.0305	-80.9562		50	52	.9293	1	0	0	0	
										74.7706	-94.4163		50	48	.9293			0	0	
			7	7	840527	C1 09542	9	1	8	73.3308	-82.1293		50	50	.3059	0	0	1	0	
										74.6940	-92.6233		50	50	.3059			1	0	
1	3	2	8	8	840527	C1 09542	6	1	8	36.0704	-95.3136		51	52	.3003	1	0	1	1	8
										37.3911	-113.5813		49	48	.2976			1	1	
			9	9	840527	C1 09542	7	0	8	36.0615	-95.3960		51	51	.2782	1	0	1	1	
										37.3662	-113.4967		49	49	.2782			1	1	
1	4	1	10	10	840527	C1 09542	8	1	8	25.7772	-100.8325		51	44	.4643	1	0	2	2	8
										26.3154	-109.0557		49	56	.4683			2	1	
1	5	1	11	11	840527	C1 09542	11	1	8	42.4615	-125.6715		52	53	.3271	1	0	1	1	8
										39.6361	-83.2387		48	47	.3247			1	1	

TABLE 7(d)

Cluster Data
Secondary Data Set

PASS #	# DET	SEQ #	CTA	BIAS	Secondary Data PTS	PPTS	STD	TREND	PROBS	PROBT	DP	TCA	AOS	DTCA	LOS	MAJOR	MINOR	DRIFT
1	1	1	11.0759	14589.	314	363	10.6123	2.2657	53	71	18	23.0099	22.9186	-2.0	23.1669	4.207	3.581	0.0000
			-10.2371	14568	318	368	11.9351	5.6294	47	29	-18		22.9186		23.1669	4.353	3.648	0.0000
1	2	2	10.7741	14208.	96	111	20.7957	3.1007	51	67	16	23.0094	22.9186	-2.0	23.1669	15.195	13.094	0.0000
			-9.9660	14187	96	111	21.6035	6.1796	49	33	-16		22.9186		23.1669	14.659	12.375	0.0000
1	3	3	-1.9305	16065.	219	412	5.6638	1.1352	50	41	-9.	23.1589	22.9186	7.0	23.1669	13.211	1.160	0.0000
			2.2140	16055	219	412	5.7240	0.8037	50	59	9		22.9186		23.1669	13.671	1.192	0.0000
1	4	4	2.2481	14782.	207	390	5.8571	2.0905	50	53	3	23.1592	22.9186	7.0	23.1669	14.142	1.260	0.0000
			-1.9590	14793	207	390	5.9432	2.3200	50	47	-3		22.9186		23.1669	14.045	1.256	0.0000
1	5	5	-1.9266	16686.	172	323	7.3423	1.9567	50	45	-5	23.1589	22.9186	7.0	23.1669	18.553	1.673	0.0000
			2.2122	16676	172	323	7.4350	1.5905	50	55	5		22.9186		23.1669	19.275	1.722	0.0000
1	6	6	-1.9240	15437.	247	465	4.0283	1.4274	50	52	2	23.1590	22.9186	7.0	23.1669	8.941	0.777	0.0000
			2.2071	15427	247	465	4.0835	1.5691	50	48	-2		22.9186		23.1669	9.266	0.802	0.0000
1	7	7	-1.4769	13525.	81	153	17.0974	3.7443	50	50	0	23.1595	22.9186	7.0	23.1669	99.591	5.940	0.0000
			1.7326	13517	81	153	17.1110	3.8180	50	50	0		22.9186		23.1669	101.923	6.028	0.0000
1	8	8	-7.1370	8252.	108	150	17.1609	8.9501	51	52	1	22.9734	22.9186	-4.2	23.1669	10.987	10.187	0.0000
			7.5750	8262	107	149	17.6056	9.8031	49	48	-1		22.9186		23.1669	12.323	11.011	0.0000
1	9	9	-7.0730	7626.	100	139	16.3438	8.7486	51	51	0	22.9733	22.9186	-4.2	23.1669	12.571	10.147	0.0000
			7.5077	7636	100	139	16.7639	9.1539	49	49	0		22.9186		23.1669	13.676	10.875	0.0000
1	10	10	-3.9139	12834.	117	232	24.7359	10.7925	51	44	-7	22.9196	22.9186	-7.4	23.1669	64.931	7.857	0.0000
			3.5019	12862	118	234	25.6544	8.6011	49	56	7		22.9186		23.1669	66.920	7.908	0.0000
1	11	11	16.4534	11845.	136	164	15.2269	5.7642	52	53	1	23.0015	22.9186	-2.5	23.1669	16.414	9.360	0.0000
			-15.4231	11781	135	162	16.6356	6.4050	48	47	-1		22.9186		23.1669	17.374	9.058	0.0000

Once the above items are better quantified then the merge in terms of the pass-to-pass clustering of data can be addressed. However, it is readily apparent that this is just a cluster analysis on a different level, i.e. the same methodology can be applied. The only difference now is that a Kalman Filter type approach should be used to derive better location estimates once ambiguity has been resolved.

6.0 REFERENCES

1. W.R. McPherson and S.Y. Slinn, "SARSAT LUT to CMCC Alert Data Interface - A Critical Review". DREO Technical Note 84-24, December 1984

2. S.Y. Slinn, " LOCAT - A Data Retrieval Program". DREO Technical Note 84-30, December 1984

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1. ORIGINATING ACTIVITY Defence Research Establishment Ottawa Department of National Defence Ottawa, Ontario K1A 0Z4	2a. DOCUMENT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. DOCUMENT TITLE

SARSAT CANADIAN MISSION CONTROL CENTRE TCA TESTS AT 121.5 MHz RESOLUTE BAY, 27-28 MAY 84

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

TECHNICAL NOTE

5. AUTHOR(S) (Last name, first name, middle initial)

McPHERSON, W. Roy

6. DOCUMENT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
JULY 1985	18	2

8a. PROJECT OR GRANT NO. 33X00	9a. ORIGINATOR'S DOCUMENT NUMBER(S) DREO TECHNICAL NOTE NO. 85-16
8b. CONTRACT NO.	9b. OTHER DOCUMENT NO.(S) (Any other numbers that may be assigned this document)

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UNLIMITED

11. SUPPLEMENTARY NOTES	12. SPONSORING ACTIVITY

13. ABSTRACT

The Canadian SARSAT users initiated field trials to test the performance of the SARSAT ground station under the conditions of fringe coverage. The data generated as a result of these trials was analyzed and results are presented. It is concluded that SARSAT can function adequately under such conditions but that this performance can only be recognized by users, if they have better visibility into available signal processing quality indicators.

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77-065

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